B. Sc. in EEE, 6th Semester May 15, 2023

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination A.Y. 2021 - 2022
Course Number: EEE 4605 Full Marks: 150
Course Title: Control System Engineering I Time : 3 Hours

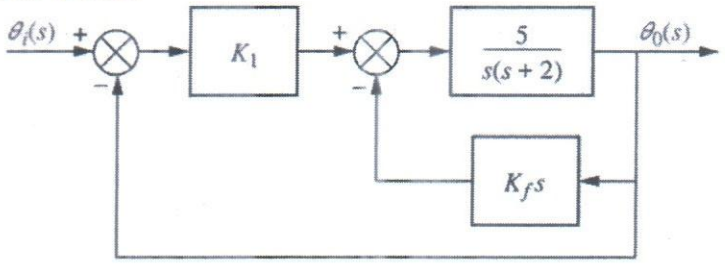
There are **05 (five)** questions. Answer **all 05 (five)** questions. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets.

1. a) Consider the following characteristic equation: **(10) (CO2) (PO2)**

$$s^4 + Ks^3 + s^2 + s + 1 = 0$$

Determine the range of K for stability.

b) The system of the following figure is to have the following specifications: $K_v = 20$; $\zeta = 0.7$. Find the values of K_1 and K_f required for the specifications of the system to be met. **(20) (CO2) (PO2)**

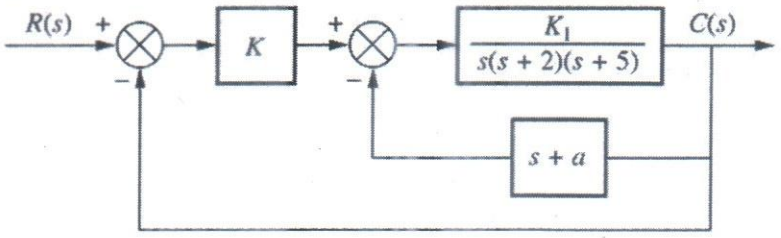


2. For a unity-feedback system with **30 CO2) (PO3)**

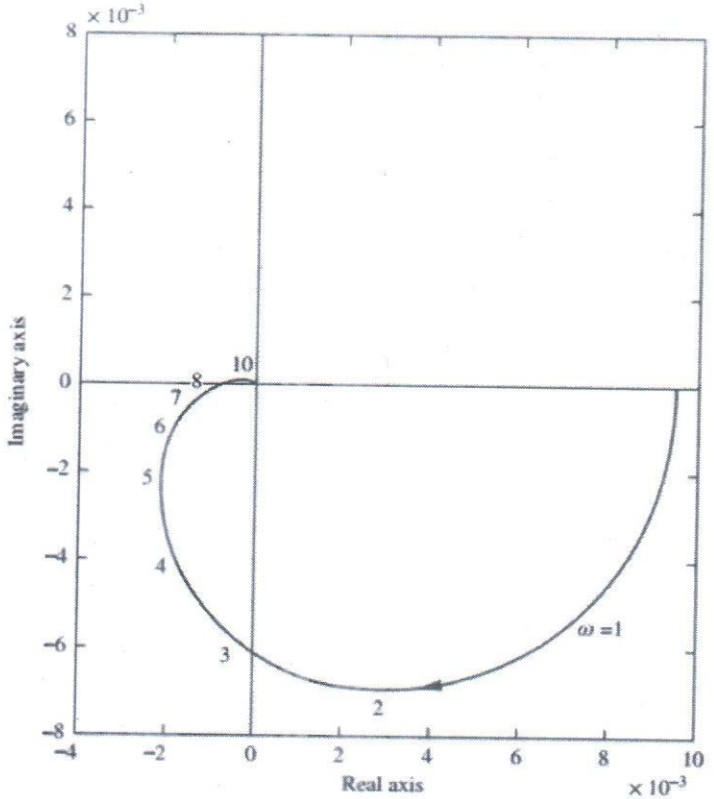
$$G(s) = \frac{K}{(s+2)(s+4)(s+6)(s+8)}$$

Find the transfer function of a lag–lead compensator that will yield a settling time of 0.5 second shorter than that of the uncompensated system. The compensated system also will have a damping ratio of 0.5 and improve the steady-state error by a factor of 30. The compensator zero is at −5. Also, find the compensated system's gain. Justify any second-order approximations.

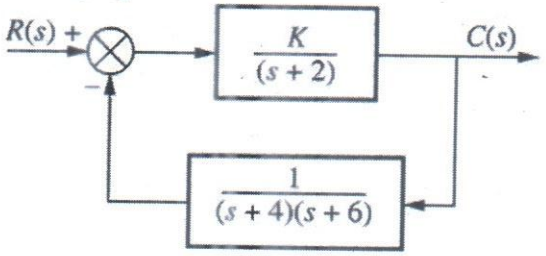
3. For the system shown in the following figure: **30**
a. Design the value of K_1, as well as a in the feedback path of the minor loop, to yield a settling time of 4 seconds with 5% overshoot for the step response. **CO2) (PO3)**
b. Design the value of K to yield a major-loop response with 10% overshoot for a step input.



4. a) Sketch the separate magnitude and phase curves from the polar plot shown in the following figure. **15 CO2) (PO2)**



b) Using the Nyquist criterion, find the range of K for stability for each of the systems in the following figure. **15 CO2) (PO2)**



5. a) Explain with suitable sketch the transient response design via gain adjustment using frequency response. Also mention when the method fails the design procedure. **10 CO2) (PO3)**

b) For the position control system shown in the following, find the value of preamplifier gain, K, to yield a 9.5% overshoot in the transient response for a step input. Use only frequency response methods. **20 CO2) (PO3)**